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REVIEWS

Igneous Rocks. Vol. I, Composition, Texture and Classification.

By JOSEPH P. IDDINGS. New York: John Wiley & Sons, 1909.

The application of modern ideas of physics and chemistry to the study of the rocks may be seen, more and more, in recent publications, and the results of these newer investigations make it necessary to look at the problems of petrology from an entirely new point of view. It is rather remarkable, and an indication of the need of a systematic presentation of the subject, that within the past few months there have appeared two volumes, following essentially similar plans, and differing entirely from previous works on petrology, namely: Professor Harker's *Natural History of Igneous Rocks*, and Professor Iddings' *Igneous Rocks*.

Professor Iddings introduces the subject with a consideration of the chemical composition of igneous rocks as a whole without regard to the mineral constituents, and he describes the various graphical methods used by petrographers to express the proportions of chemical elements in these rocks.

The magma, solidifying as a rock, takes, in general, the form of a mass of crystals with definite chemical and physical characters, and more or less glass. The relations to each other of the so-called pyrogenetic, or primary, minerals are shown by the presence in them of elements which occur together in the same groups in Mendeléeff's table. Consequently many of the minerals in a given rock are characterized by their content of different amounts of the same element.

The principles of physics and chemistry applicable to rock magmas are fully discussed. Rock magmas are now believed by everyone to be, not simple melts, but solutions of minerals at high temperatures which may act like solutions of other compounds at lower temperatures. In the latter, the reactions taking place, the processes of solidification which convert them into glasses or crystals, and the physical characters and molecular constitution of the liquid solutions are more easily understood than they are in rock magmas at high temperatures and pressures. In order to study properly the facts of physical chemistry, there are discussed the kinetic theory of gases, liquids, and solids, the melting points of rock minerals, and the physical characters and chemical reactions of solutions. After this preliminary statement of principles, the discussion of the chemi-

cal and physical behaviors of molten magmas is begun with the consideration of the chemical reactions which give rise to minerals, and which would probably take place, within the earth, between the elements occurring in igneous rocks. From these studies the laws governing the association of certain minerals in the rocks are deduced.

In consequence of changes of physical conditions, the molten magma separates into solids, gases, and, to a small extent, liquids. These processes are complicated by variable factors such as change of chemical reactions or degree of supersaturation under different conditions of temperature and pressure produced by the movements of eruption. The causes of this separation, the order and the effect of supersaturation upon it, the effect of viscosity upon the rate, and the separation taking place in isomorphous compounds and eutectic mixtures, are discussed.

Following this presentation of the subject of the separation of substances from solution, is a chapter on the crystallization and texture of igneous rocks, the terms used being those recently proposed by Cross, Iddings, Pirsson, and Washington.¹ The degree of crystallization of a rock magma and the amount of glass affect both the mineral constituents of the resulting rock and its texture. The extent of crystallization, the magnitude, shape, and arrangement of the crystals or amorphous parts, and the factors which influence texture are fully described and illustrated.

The differentiation, or splitting-up of a homogeneous rock magma into chemically unlike portions, is next considered. The evidences of such separation are divided into two groups: (1) Igneous rocks differing in chemical composition in different parts of the same body; and (2) igneous rocks of different compositions associated in regular manner with reference to place of occurrence and time of eruption, and possessing such chemical characteristics that their previous existence as components of a homogeneous magma is clearly indicated.

The agencies which are likely to affect the character of a rock magma are changes of temperature, pressure, or gas content, and Professor Iddings considers the way in which each of these may act upon certain physical or chemical characters of the magma. They may change the density of the liquid magma in certain parts and produce convection currents, or they may change the viscosity and modify the diffusivity. A change in osmotic pressure would produce a variation in the molecular concentration in different portions, a change in saturation or chemical equilibrium would affect the crystallization and the resulting minerals, and a change in the character of the solidification would affect the texture of the rock. The

¹ *Jour. Geol.*, Vol. XIV, 1906, pp. 692-707.

chapter closes with a brief sketch of various hypotheses that have been suggested in explanation of differentiation, and a statement of the processes of magma eruption.

A discussion of structures and the modes of occurrence of extrusive and intrusive igneous rocks concludes part one. By the term structure, Professor Iddings follows the more recent usage, restricting it to those "large features of rock bodies which have been produced by cracking, by fracturing and aggregation, or which may be brought about by erosion," the term texture being applied to the microscopic features.

The second part of the volume, which consists of 121 pages, is taken up with nomenclature and classification of igneous rocks. After a short historical sketch, the author presents an adaption of the current qualitative systems of classification. The definitions of the rocks are essentially those of Rosenbusch and of Zirkel given in terms of mineral composition and texture with no expression of views as to the possible genetic relations between them. Professor Iddings divides the rocks into five groups based on the dominance of (1) quartz, (2) quartz and feldspar, (3) feldspar, (4) feldspar and feldspathoid, (5) feldspathoid. Each of these is separated into divisions based on the character of the preponderant feldspathic constituent, and these, in turn, into divisions with little or much ferromagnesian minerals. The final divisions are into phanerocrystalline and aphanitic rocks; the latter having two subdivisions, those of cenotypal and those of paleotypal habit.

The last chapter of the book, consisting of 61 pages, is taken up with the quantitative classification of Cross, Iddings, Pirsson, and Washington, and is an abridgment of the system published by them in 1902.¹ The rules for the calculation of the norm have been rewritten and are now much clearer than formerly, the explanatory notes interpolated in the older work being omitted.

It is only in this second part of Professor Iddings' book that it differs widely from that of Professor Harker. In both books the treatment of the newer petrology is similar, but the two writers differ entirely upon the question of classifications, although they agree that the existing systems are unsystematic, unsatisfactory, and confusing. Professor Harker has given but 18 pages to classifications, and one could wish that he had further developed his own ideas on the subject, especially in the way of a classification based upon eutectics, such as was suggested by Becker² and Vogt.³

¹ *Jour. Geol.*, Vol. X, 1902, pp. 555-690.

² Geo. F. Becker, *21st An. U. S. G. S.*, III, 1899-1900, pp. 519, 520.

³ J. H. L. Vogt, "Ueber anchi-eutektische und anchi-monomineralische Eruptivgesteine," *Norsk Geol. Tidsskr.*, 1905, Vol. I, No. 1.

It is his view that "the establishment of a genetic classification is dependent only on a fuller knowledge of facts and principles," and "a systematic treatment of igneous rocks on these lines . . . is not to be expected in the immediate future." Professor Iddings has made no attempt at a genetic classification, believing that there are too many factors influencing genetic relations to permit of their use. He thinks that the chemical composition of an igneous rock is "its most fundamental character . . . and is therefore of greatest importance for its correlation with other igneous rocks."

Professor Iddings' book is a most valuable addition to the literature of petrology and will be welcomed by students for its presentation of the new view of those problems which, to a large extent, have heretofore been given only in scattered publications, representing the work of such men as Day and his colleagues in the Geophysical Laboratory, Doelter, and Vögt.

The book is well printed on good paper, the half-tones are clear, and the line drawings are neat. The book is bound in blue cloth uniformly with the same author's *Rock Minerals*.

A. J.

Through the Yukon and Alaska. By T. A. RICKARD. I-XIII, pp. 384. San Francisco: Mining and Scientific Press, 1909.

Few if any travelers in Alaska have made so many and such accurate observations as Mr. Rickard, and of those who have published similar journals, no one has included so much of real value to those interested in the resources of the Yukon district and Alaska, or in the mining activities of those countries. The author has told in a delightful way many of the incidents of travel, and has taken pains to give accurately the history of some of the most remarkable discoveries in these northern countries. The romantic history of the Treadwell mines, the discovery of gold on the Klondike, the wonderful development at Fairbanks, and the story of the discovery and exploitation of the Nome beach, are here given in a fuller and more interesting way than they have elsewhere appeared. Mr. Rickard has retold many of the stories associated with life in Alaska, during the exciting periods from 1895 to 1900: thus the fake discovery of a Silent City, the story of Soapy Smith and his gang of desperadoes, the incidents associated with the great stampede over White Pass and Chilkoot Pass, the life at Dawson, on Cleary Creek, and the story of many events at Nome which have afforded material for novels and magazine articles, are given in a very readable form. The book is, however, more than a